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APPLICATION FOR UNITED STATES PATENT

TITLE

OVERVOLTAGE PROTECTION DEVICE IN COMMON/DIFFERENTIAL MODE OF REDUCED SIZE

INVENTORS

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PRIORITY CLAIM

[001] This patent application is the U.S. National Phase of International Application No. PCT/FR/2005/000524, having an International Filing Date of March 4, 2005, which claims priority to France Patent Application No. 0402367, filed March 5, 2004, the disclosures of which are incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

[002] This invention relates to the general technical domain of devices for protection of electrical installations against overvoltages, and particularly transient overvoltages due to lightning.

[003] More precisely, the invention relates to a device for protection against overvoltages that is adapted to provide protection in common and differential modes and comprising at least one electrically isolating package specifically adapted to receive at least one electrical binomial formed by a so-called phase - earth varistor with a phase terminal and an earth terminal, arranged between a first phase to be protected and the earth, and a so-called phase - neutral varistor with a phase terminal and a neutral terminal arranged between said first phase to be protected and the neutral, said phase - earth and phase - neutral varistors being installed one adjacent to the other within said package so as to form an assembly binomial.

BACKGROUND OF THE INVENTION

[004] Devices for protection of electrical installations against overvoltages are widely used and may be commonly referred to as "lightning arresters". Their essential purpose is to allow lightning currents to travel to earth, and possibly to clip additional voltages induced by these currents to levels compatible with the behaviour of the equipment and instruments to which they are connected.

[005] Conventionally, there are two modes for protection against overvoltages, namely common mode MC in which the protection components are connected between active conductors (phase or neutral) and the earth, and differential mode MD in which the protection components are connected between active conductors (i.e., between phases and the neutral).

[006] Protection devices with varistors are usually used to protect the installation in these two common and differential modes.

[007] In known devices, one varistor is usually installed per branch, in other words if the protection device is to protect a single-phase network, it must include an electrical

binomial formed from at least two varistors so as to provide protection in the two above-mentioned modes. Thus in single-phase, the electrical binomial will generally comprise a so-called phase - earth varistor connected between the phase to be protected and the earth, and a so-called phase - neutral varistor connected between said phase to be protected and the neutral. In the case of a three-phase network, at least three electrical binomials are necessary to perform the same function.

[008] In accordance with requirements of standards (NF-EN 61643-11 and NF C 61740/95), the end of life of the varistors must be controlled, which requires the use of integrated disconnectors, for example thermal disconnectors, each varistor then being provided with its own disconnection system. The varistor and its disconnection system are then installed in a support package, the assembly forming what will be called a "motor" in the remainder of this description.

[009] Known common mode / differential mode protection devices thus usually comprise at least two packages (or motors) for protection in the two modes mentioned above in the case of a single-phase network, and at least six packages (or motors) for protection in the case of a three-phase network, each package (or motor) comprising a single varistor.

[0010] Although known devices do provide satisfactory protection for the electrical network or installation, they also suffer from a number of disadvantages.

[0011] Firstly, such devices are particularly large, each package (or motor) occupying its individual space, and this space is multiplied by the number of packages used. It is understandable that these devices may occupy a non-negligible volume in a multi-phase network, while the objective for an increasing number of applications is to reduce the size of protection devices and to make them as discrete as possible.

[0012] Furthermore, withdrawable versions of known devices are usually made with two cartridges per phase, in other words with at least two interchangeable cartridges in the case of a single-phase network and with at least six interchangeable cartridges in the case of a three-phase network.

[0013] However, such a configuration is particularly complex for a user who logically expects to find a single cartridge per phase rather than two cartridges per phase as in known devices.

[0014] It is known that varistors can be combined with a spark gap, to overcome these disadvantages.

[0015] In the case of a single-phase network, the lightning arrester then comprises a so-called phase - neutral varistor connected between the phase to be protected and the neutral point, and a spark gap connected between the neutral point and the earth. In withdrawable versions of the device, each protection component is integrated into an individual cartridge such that the lightning arrester comprises two interchangeable cartridges, only one of which is connected to the phase to be protected, which actually corresponds to the logical configuration expected by the user. Equivalently, in the case of a three-phase network, the lightning arrester will comprise three varistors, each connected between a phase to be protected and the neutral, and a spark gap connected between the neutral and the earth, each protection component being integrated into an individual cartridge. Thus, in the case of a three-phase network, the lightning arrester comprises four withdrawable cartridges, including three cartridges that are connected to the three phases to be protected, namely one cartridge per phase which corresponds to what the user would intuitively expect to find.

[0016] Such devices thus protect the network firstly in common mode, by putting the two phase - neutral and neutral - earth branches in series, and secondly in differential mode due to the phase - neutral branch.

[0017] However this assembly cannot be used for all network types, and particularly networks for which the neutral to earth connection scheme is of the IT (neutral isolated from the earth or impedant) type.

[0018] Furthermore, this assembly is not suitable for cascading of lightning arresters. In particular, when a first lightning arrester on the input side comprises a varistor in its neutral - earth branch, and a second lightning arrester on the output side comprises a spark gap in its neutral - earth branch, the spark gap placed on the output side will carry

most of the lightning current in the case of an overvoltage while the varistor on the input side will not be highly loaded, which is contrary to the required objectives when two lightning arresters are used together.

[0019] Therefore, it is useful to attempt to make a device for protection against overvoltages that can operate in both common and differential modes that, while being compact, is compatible with all types of neutral to earth connection schemes, and particularly the TT, TN-S, TN-C or IT regimes, thus facilitating the final User's choice, particularly because the information related to the network neutral regime is not necessarily known to the user.

SUMMARY OF THE INVENTION

[0020] Consequently, the features of the invention are to correct the various disadvantages mentioned above and offer a new protection device against overvoltages and that is adapted to provide protection in common and differential modes that does not have the disadvantages listed above and which, while being compatible with all neutral to earth connection schemes, has a limited size.

[0021] Another feature of the invention is to provide a new protection device for which maintenance is particularly easy.

[0022] Another feature of the invention is to provide a new protection device that is particularly easy to use logically and intuitively in its withdrawable version.

[0023] Another feature of the invention is to describe a new protection device that is particularly easy to adapt to each network type.

[0024] The features assigned to the invention are achieved using a device for protection against overvoltages that is adapted to provide protection in common and differential modes, and comprising at least one electrically isolating package, specifically adapted to contain at least one electrical binomial formed by a so-called phase - earth varistor with a phase terminal and an earthing terminal, arranged between a first phase to be protected and the earth, and a so-called phase - neutral varistor with a phase terminal and a neutral terminal, arranged between said first phase to be protected and the neutral,

said phase - earth and phase - neutral varistors being installed side by side within said package so as to form an assembly binomial, characterised in that the protection device includes means of electrical insulation adapted to electrically isolate the phase - earth varistor earthing terminal from the phase - neutral varistor neutral terminal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Other special features and advantages of the invention will become clearer and details will be given in the following description with reference to the appended figures given purely for illustrative and non-limitative purposes, wherein:

[0026] - Fig. 1 shows a partial sectional view of a package inside which an assembly binomial is assembled.

[0027] - Fig. 2 illustrates a general perspective view of the package according to the invention in a withdrawable version.

[0028] - Fig. 3 illustrates a perspective view of a base on which the package illustrated in Fig. 2 will be assembled.

[0029] - Fig. 4 illustrates an electrical principle diagram for the device for protection against overvoltages according to the invention, in the case of a single-phase network.

[0030] - Fig. 5 illustrates an electrical principle diagram for the device for protection against overvoltages according to the invention, in the case of a three-phase network.

DESCRIPTION OF THE INVENTION

[0031] The device for protection against overvoltages conforming with the invention is designed to be connected in parallel on the electrical equipment or installation to be protected.

[0032] The expression "electrical installation" refers to all types of instruments or networks that may be disturbed by various origins of voltage disturbances, and particularly transient overvoltages due to lightning.

[0033] The protection device according to the invention is preferably a low voltage lightning arrester, in other words it is preferably designed to protect low voltage installations (for example, of 50 Volts to 750 Volts).

[0034] The device 1 for protection against overvoltages will now be described with reference to Figs. 1 to 5.

[0035] The device 1 for protection against overvoltages is adapted to provide protection in common and differential modes, in other words it must be useable in common mode or in differential mode, without it being necessary to modify the device in any manner and particularly the nature and assembly of the protection components from which it is made.

[0036] According to the invention, and as shown in Figs. 1 and 2, the protection device 1 comprises at least one electrically isolating package 2, in other words advantageously made from a material that does not conduct electricity.

[0037] According to the invention, the protection device 1 also comprises at least one electrical binomial formed from a so-called phase - earth varistor PT arranged between a first phase L1 to be protected and the earth T and a so-called phase - neutral varistor PN arranged between said first phase L1 to be protected and the neutral N.

[0038] Thus, the phase - earth varistor PT is arranged to protect the electrical installation in common mode (i.e., between an active conductor and the earth), while the phase - neutral varistor PN is arranged to provide protection in differential mode (i.e., between two active conductors).

[0039] According to the invention and as shown in Fig. 1, the package 2 is specifically adapted to receive the electrical binomial formed by the phase-earth varistor PT and the phase-neutral varistor PN, in other words it is sized to hold not more than two varistors.

[0040] According to the invention, the phase - earth varistor PT and the phase-neutral varistor PN forming the electrical binomial, are installed side by side in the package 2, so as to form an assembly binomial 3. The protection device 1 thus designed is advantageously compact, the phase - earth varistor PT and the phase - neutral varistor

PN no longer being assembled in individual packages as they are in devices according to prior art, but are contained within the same package 2.

[0041] In accordance with the requirements of standards, each phase - earth varistor PT or phase - neutral varistor PN is advantageously provided with its own disconnection means, preferably of the thermal type such that thermal runaway is stopped sufficiently early when varistors age.

[0042] Particularly advantageously, and as shown in Fig. 1, the disconnection means may be formed by a disconnection strip 4 that extends between two ends 4A, 4B, one of said ends 4A preferably being fixed using a heat-fusion weld onto one of the poles of the associated varistor. The end 4A of the disconnection strip 4 is thus preferably stress welded, such that a temperature rise in the varistor near the end of its life will cause fusion of the weld that, once broken, will release the disconnection strip 4 and therefore will disconnect the associated varistor from the electrical installation. The package 2, provided with its phase - earth varistor PT and the phase - neutral varistor PN provided with their disconnection means 4, then advantageously form a "double" motor, in other words a motor with two varistors.

[0043] Obviously, the package 2 could be formed from a single support, not necessarily closed, but specifically adapted to receive the electrical binomial formed by the phase - earth varistor PT and the phase - neutral varistor PN.

[0044] According to another particularly attractive special feature of the invention, the protection device 1 thus designed can easily be adapted to be in a withdrawable form.

[0045] To achieve this, the protection device 1 advantageously includes a preferably fixed base 6, in other words permanently connected to the electrical installation to be protected (Fig. 6).

[0046] Particularly advantageously, each package 2 is then provided with plugging-in / withdrawal means 7 (Fig. 2) adapted to enable the removable electrical connection of the package 2 relative to the base 6. As shown in Fig. 2, the plugging-in / withdrawal means 7 are advantageously formed from four studs 8A, 8B, 9A, 9B used to plug the package 2 onto the base 6. The poles of the phase - earth varistor PT and the phase -

neutral varistor PN are thus advantageously connected firstly to studs 8A, 8B, and secondly to studs 9A, 9B, respectively.

[0047] Furthermore, the base 6 is preferably provided with a housing 10 arranged to receive the package 2, with four openings 8'A, 8'B, 9'A, 9'B being provided on the bottom 10A, specifically adapted to hold studs 8A, 8B, 9A, 9B, respectively.

[0048] Particularly advantageously, the package 2 with its plugging-in / withdrawal means 7 forms an interchangeable cartridge 11. Thus, when the phase - earth varistor PT or the phase - neutral varistor PN is degraded and disconnected, the User can unplug the cartridge 11 from the base 6 in order to replace it. This operation is particularly easy and logical due to the univocal link existing between the cartridge 11 and the phase to be protected.

[0049] Several exemplary embodiments of the invention will now be described with reference to Figs. 4 and 5.

[0050] According to a first exemplary embodiment of the invention shown in Fig. 4, the protection device 1 is designed to protect a single-phase network. To achieve this, the protection device 1 comprises at least one package 2 (shown in dashed lines in Fig. 4) provided with an assembly binomial formed by a phase - earth varistor PT and a phase - neutral varistor PN, said assembly binomial being electrically connected to the phase L1 to be protected. As shown in Fig. 4, the phase - earth varistor PT is electrically connected between the phase L1 to be protected and the earth T thus providing protection in common mode, and the phase - neutral varistor PN is connected between the phase L1 and the neutral point N so as to provide protection in differential mode.

[0051] According to a second exemplary embodiment of the invention shown in Fig. 5, the protection device 1 is designed to provide protection of a three-phase network and to achieve this it comprises at least three packages 2A, 2B, 2C (shown in dashed lines in Fig. 5), each provided with an assembly binomial electrically connected to one of the phases L1, L2, L3 to be protected. Thus, the package 2A encloses a phase - earth

varistor PT connected between the first phase L1 to be protected and the earth, and a phase - neutral varistor PN connected between said phase L1 and the neutral point N.

[0052] Similarly, the package 2B comprises a phase - earth varistor PT connected between the second phase L2 to be protected and the earth, and a phase - neutral varistor PN connected between the second phase L2 and the neutral point N.

[0053] Finally, the third package 2C comprises a phase - earth varistor PT connected between the third phase L3 to be protected and the earth, and a phase - neutral varistor PN connected between said third phase L3 and the neutral point N.

[0054] In general, the protection device 1 according to the invention may be adapted to protect a multi-phase network with a number N of phases. In this case, the protection device 1 will advantageously comprise a number of packages equal to at least the number N of phases, each package 2 being provided with an assembly binomial 3. In this case, the protection device 1 is said to be "multi-pole".

[0055] Preferably, the protection device 1 comprises isolating means 30 when it is multi-pole, arranged between two consecutive assembly binomials 3, in other words adjacent to each other, so as to isolate them from each other electrically. The isolating means 30 thus avoid the formation of short circuits that can occur between two consecutive and nearby assembly binomials 3 due to their connection to active conductors and particularly phases L1, L2, L3 at different potentials. Due to the isolating means 30, the assembly binomials 3 can be brought towards each other and therefore the global size of the device can be reduced while avoiding the formation of short circuits between two consecutive assembly binomials 3.

[0056] Preferably, the isolating means 30 are formed from a screen made of an insulating material inserted between two consecutive assembly binomials 3. The isolating means 30 and particularly the isolating screen are advantageously designed and sized so as to increase the isolation distance between two consecutive assembly binomials 3, so as to prevent the formation of electrical arcs between these binomials while maintaining a low gap distance, less than the isolation distance, between the assembly binomials 3 so as to limit the size of the device.

[0057] The expression "isolation distance" in this description refers to the minimum distance to be travelled by the electrical arc in the gaseous dielectric medium, for example air, separating the assembly binomials 3. The presence of isolating means 30, particularly the isolating screen, can increase the isolation distance by forcing the electrical arc to circumvent them.

[0058] For networks for which the neutral to earth connection scheme is not of the IT (neutral isolated from earth or impedant) type, the protection device 1 may include a so-called neutral - earth varistor NT arranged between the neutral and the earth, said varistor being installed within an additional package 2S as shown in Figs. 4 and 5. The additional package 2S may either be arranged specifically to contain a single varistor, or it may be similar to package 2 in all respects except that it will only receive a single neutral - earth varistor NT as illustrated in Figs. 4 and 5. In this case, some 2V of the additional package 2S will be unused.

[0059] Obviously, for networks for which the neutral to earth connection scheme used is of the IT (impedant neutral or isolated from earth) type, all that is necessary is to eliminate or withdraw (in the case of a withdrawable version) the additional package 2S, the protection device 1 then only comprising a single package 2 in the case of a single-phase network and three packages 2A, 2B, 2C in the case of a three-phase network.

[0060] Thus the protection device 1 according to the invention is advantageously compact, with not more than two packages 2, 2S in single-phase and not more than four packages 2A, 2B, 2C, 2D in three-phase. Furthermore, since the protection device 1 only contains a single package 2, 2A, 2B, 2C (or motor) for each active conductor, manipulation of withdrawable versions of this device is particularly easy and the User intuitively associates a phase L1, L2 or L3 to be protected with a single corresponding cartridge 11.

[0061] This aspect of the invention will be particularly attractive in the case of multiphase networks comprising a large number of active conductors. Thus, as the number of active conductors increases, the protection device 1 according to the

invention becomes more advantageous compared with devices according to prior art in terms of size and ease of use.

[0062] If the protection device 1 comprises several interchangeable cartridges 11, each cartridge 11 being associated either with a phase L1, L2 or L3 to be protected or with the neutral point N, the base 6 (shown in dashed lines in Figs. 4 and 5) may comprise several housings, each housing possibly holding a cartridge 11, or a single housing arranged to hold all the above mentioned cartridges 11.

[0063] As shown in Figs. 4 and 5, each phase - earth varistor PT, each phase - neutral varistor PN and each neutral - earth varistor NT is connected to the network through electrical connection means 15, the electrical connection to the earth being made using other electrical connection means 16. The electrical connection means 15, 16 are preferably and conventionally wire connection means.

[0064] Advantageously, each phase - earth varistor PT comprises a so-called phase terminal p electrically connected to phase L1, L2, L3 to be protected and a so-called earthing terminal t electrically connected to the earth T.

[0065] Similarly, each phase - neutral varistor PN comprises a so-called phase terminal p electrically connected to the phase L1, L2 or L3 to be protected and a so-called neutral terminal n electrically connected to the neutral N. As shown in Figs. 4 and 5, the phase - earth varistor PT and the phase - neutral varistor PN are arranged adjacent to each other within the package 2, 2A, 2B, 2C. The neutral terminal n and the earthing terminal t are not at the same potential such that if they are too close to each other, an electrical arc can form between said n, t terminals, thus short circuiting the protection device 1.

[0066] In order to avoid this phenomenon, the protection device 1 advantageously comprises electrical insulation means 20 adapted to electrically isolate the earthing terminal t from the neutral terminal n, and preferably arranged inside the package 2, 2A, 2B, 2C. The electrical insulation means 20 are advantageously positioned and arranged so as to form an isolating screen between said earthing terminal t and said neutral terminal n.

[0067] As an illustrative and non-limitative example, the electrical insulation means 20 may be formed by an electrically isolating separation partition 21 inserted between the earthing terminal t and the neutral terminal n so as to assure electrical insulation between said earthing terminal t and said neutral terminal n.

[0068] Advantageously, the electrical insulation means 20 are designed and sized to increase the isolation distance between the earthing terminal t and the neutral terminal n, such that the isolation distance is greater than the real separation distance separating said earthing terminal t and the neutral terminal n.

[0069] Thus the electrical insulation means 20 are used to shorten the separation distance between the neutral terminal n and the earthing terminal t, thus reducing the size of the device while guaranteeing electrical insulation of the terminals, and while increasing the isolation distance between the neutral terminal n and the earthing terminal t, in other words, the length of the path to be travelled by the electrical arc between said neutral terminal n and earthing terminal t to circumvent the electrical insulation means 20.

[0070] For example, the separation partition 21 may extend over a just sufficient area to assure insulation between the earthing terminal t and the neutral terminal n.

[0071] Preferably, as shown in Fig. 1, the separation partition 21 will be arranged preferably inside the package 2 so as to separate the package into two housings 22, 23 that are approximately symmetrical with respect to the separation partition 21, each housing 22, 23 being capable of holding a varistor provided with its disconnection means. Even more preferably, and as shown in Figs. 1 and 2, the separation partition 21 may extend outside the package 2 so as to separate the pair of studs 8A, 8B associated with the phase - earth varistor PT from the pair of studs 9A, 9B associated with the phase - neutral varistor PN.

[0072] In this case, the base 6 will advantageously comprise a central housing 60 specifically adapted to hold the outgoing end of the separation partition 21 when the package 2 is plugged into the base 6.

[0073] In particular, such a configuration may prevent the formation of electrical arcs between the studs 8A, 9A at different potentials, connected to the earthing terminal t and the neutral terminal n respectively when plugging in.

[0074] According to one preferred alternative exemplary embodiment of the invention, the phase - earth varistor PT and the phase - neutral varistor PN in the same assembly binomial 3 have different operating voltages from each other. Advantageously, the phase - neutral varistor PN is provided with an operating voltage less than the operating voltage of the phase - earth varistor PT, so that firstly the protection level of the lightning arrester may be reduced, and secondly the electrical binomial can be more compact. Thus, as an illustrative and non-limitative example, the phase - earth varistor PT can have an operating voltage of the order of 440 Volts so as to resist the voltage between phases (of the order of 400 Volts) as required by French standards, the phase - neutral varistor PN having a lower operating voltage of the order of 275 Volts. Thus in the case of unpluggable versions of the protection device 1, each cartridge 11 advantageously has a pair of varistors with different values without creating any confusion in the mind of the User, because every active conductor remains associated with a single cartridge 11.

[0075] The invention also relates to a method for manufacturing a device 1 for protection against overvoltages, suitable for providing protection in common and differential modes, said method comprising steps to:

-a) make at least one electrically isolating package 2;

-b) make at least one electrical binomial, consisting of a phase - earth varistor PT that will be arranged between a first phase L1 to be protected and the earth T and a phase - neutral varistor PN that will be arranged between the first phase L1 to be protected and the neutral N.

[0076] According to the invention, the method also comprises the following steps:

-c) specifically arrange the package 2 so that the electrical binomial can fit into it;

-d) associate the two varistors PT, PN, into an assembly binomial 3, and install them side by side within the package 2.

[0077] Advantageously, the method also includes a step in which the package 2 is provided with plugging-in / withdrawal means 7 to connect said package 2 onto a fixed base 6 in a manner such that it can be removed.

[0078] Particularly advantageously, the phase - earth varistor PT comprises a phase terminal p electrically connected to the phase L1, L2 or L3 to be protected and a so-called earthing terminal t, electrically connected to the earth T, and the phase - neutral varistor PN comprises a so-called phase terminal p electrically connected to said phase L1, L2 or L3 to be protected and a so-called neutral terminal n electrically connected to the neutral, and the method also includes a step in which electrical insulation means 20 are provided between the earthing terminal t and the neutral terminal n.

[0079] The method also advantageously includes the following steps:

-e) make a so-called neutral - earth varistor NT that will be placed between the neutral N and the earth T;

-f) install said neutral - earth varistor NT within an additional package 2S, preferably unpluggable.

[0080] The invention can thus significantly reduce the dimensions and therefore the size of a protection device 1 of the common mode / differential mode type while guaranteeing electrical insulation between components of the device with different potentials.

[0081] Another advantage of the invention is that it enables easy and intuitive withdrawal of out-of-use protection components, in order to replace them.

[0082] Another advantage of the protection device 1 according to the invention is that it can be used regardless of the connection scheme of the neutral to the earth.

[0083] Another advantage of the invention is due to the fact that the protection device 1 conforming with the invention requires fewer parts, and particularly motors, than devices according to prior art, while performing the same functions. Therefore the solution proposed by the invention is more economic than existing solutions.

[0084] Another advantage of the invention is that it helps to rationalise the manufacturing method for the protection device 1 according to the invention, particularly by the systematic use of double motors.

[0085] One industrial application of the invention is for the design and manufacture of devices for the protection of transient overvoltages.

[0086] All patents, applications and publications referred to herein are incorporated by reference in their entirety.